

EBENACEAE HARDY IN TEMPERATE NORTH AMERICA¹

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EBENACEAE Gürke in Engler & Prantl, Nat. Pflanzenfam. IV. 1: 153. 1891,
nom. cons.

(EBONY FAMILY)

Evergreen or deciduous trees and shrubs, usually with very hard, blackish wood and watery sap. Leaves simple, alternate or rarely opposite or whorled, exstipulate, mostly with entire margins, the venation pinnate. Flowers actinomorphic, imperfect (and the plants dioecious or sometimes monoecious), or sometimes occasional flowers perfect (and the plants polygamous or polygamodioecious); staminate flowers usually in few-flowered, axillary, cymose inflorescences; carpellate flowers axillary, usually solitary. Calyx synsepalous, articulated at base, 3–7-lobed, often accrescent in age. Corolla sympetalous, 3–7-lobed, the lobes usually contorted, imbricate (or rarely valvate) in bud. Stamens usually 2 or 3 times the number of corolla lobes, epipetalous (or rarely hypogynous), in 2 or more whorls, the filaments free or connate, the anthers 2-loculate; in carpellate flowers the androecia reduced to staminodia or absent. Gynoecium syncarpous, the styles connate for all or a portion of their length; ovary superior, 2–16 (–20)-locular, each locule with 1 or 2 pendulous, anatropous, bitegmic ovules; in staminate flowers the gynoecia vestigial or absent. Fruit a berry, often succulent, usually subtended by the persistent calyx. Seeds with thin coats, the straight or slightly curved embryos with foliaceous cotyledons, embedded in copious cartilaginous or sometimes ruminant endosperm. (Guaiacanae Jussieu, Diospyraceae Novak; including Lissocarpaceae Gilg; excluding Onocatheaceae Kobuski ex Airy Shaw.) TYPE GE-

¹ This treatment of the Ebenaceae is the fourth contribution in a series of treatments of cultivated ligneous plants, the preparation of which is a project of the Arnold Arboretum of Harvard University, and the purpose of which is to provide a modern, accurate account of the woody plants encountered in cultivation in the cooler temperate regions of North America. It is hoped that these treatments will eventually form the basis of a new manual of cultivated woody plants. The first paper in this series was published in the *Journal of the Arnold Arboretum* 56: 1–19. 1975. Reference should be made to the introductory paragraphs of that paper for matters concerning area covered, taxa included, and the general philosophy of these treatments.

Special thanks and gratitude are extended to the Director and trustees of the Stanley Smith Horticultural Trust for a grant that has made possible the illustrations to accompany these treatments. The illustrations are the careful work of Robin S. Lefberg and were prepared from living and alcohol-preserved specimens collected in the Arnold Arboretum and at the Henry Foundation for Botanical Research, Gladwyne, Pennsylvania.

For their contributions of time and advice and encouragement, I am indebted to my colleagues on the staff of the Arnold Arboretum and to many botanical and horticultural friends and colleagues. Particular thanks are extended to my wife, Harmony, to Dr. J. C. McDaniel, Mr. J. Witt, and Dr. B. G. Schubert. S. A. S.

NUS: *Ebenus* Burm. ex O. Kuntze = *Maba* J. R. & G. Forster = *Diospyros* L.

Upwards of 500 species in three to five genera distributed primarily in tropical and subtropical climates in both eastern and western hemispheres. Relatively few species are native in the Temperate Zone of North America and Asia; and other than species of *Diospyros* and *Lissocarpa* Benth (two species of tropical South America), the genera of Ebenaceae are confined to Africa and Madagascar. *Diospyros* is the only genus with species both native to and cultivated in our area in North America.

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Diospyros Linnaeus, Sp. Pl. 2: 1057. 1753; Gen. Pl. ed. 5. 478. 1754.

Evergreen to deciduous trees and shrubs with very hard, often black wood; bark smooth, sometimes exfoliating, to deeply fissured and checkered; branchlets glabrous to densely pubescent, the pith continuous; winter buds (in ours) with 2 outer scales, these often persistent at the base of lateral shoots, terminal buds lacking. Leaves alternate, petiolate to subsessile, the membranaceous to coriaceous blades with entire, sometimes ciliate margins. Flowers staminate or carpellate (rarely perfect), and the plant dioecious, occasionally monoecious (or, due to the presence of occasional perfect flowers, the plants polygamous or polygamodioecious); staminate flowers 2-5 together, rarely solitary, short-pedicellate in short-pedunculate, bracteate, axillary cymose inflorescences; carpellate flowers usually solitary in the axils of leaves on short, bracteate pedicels. Calyx articulated at base, usually 4-lobed, occasionally 3-7-lobed, in carpellate flowers persistent, often accrescent. Corollas urceolate to \pm campanulate, 3-7-, usually 4-lobed, the lobes spreading or recurved at anthesis. Stamens

usually 2 or 3 times the number of corolla lobes, free or occasionally in pairs, epipetalous in 2 or 3 whorls, the anther sacs linear-lanceolate, dehiscent by longitudinal slits; in carpellate flowers the androecium represented by staminodia or absent. Gynoecia absent or rudimentary in staminate flowers, in carpellate flowers the ovary superior, 3-16-, usually 8-locular, each locule with 1 or 2 ovules; styles usually 4, connate at least basally. Berries occasionally parthenocarpic and seedless, otherwise with seeds, depressed-globose, globose to oblong or conical, green through yellow to reddish-orange or brownish, blackish, or purplish when mature, often \pm glaucous, the edible berries usually astringent prior to maturity due to high tannin content, becoming sweet and juicy with soft, pulpy flesh when ripe; seeds oblong to \pm rounded, flattened, with \pm shining, brown coats, the endosperm cartilaginous or sometimes ruminant. (Including *Maba* J. R. & G. Forster, *Brayodendron* Small.) LECTOTYPE SPECIES: *D. lotus* L., see N. L. Britton, N. Am. Trees 785. 1908. (Name from Greek, *Dios*, of Zeus or of Jove, and *pyros*, grain, in allusion to the sweet, edible fruits of the type species.) — PERSIMMON, DATE PLUM.

A taxonomically difficult genus of approximately 400 species of tropical to temperate climates in the Americas, Asia, and Africa. The greatest concentrations of species occur in Madagascar, from which over 100 species are known, in Malaysia, and in Africa. Relatively few species are known from the Temperate Zone, but two are native to the United States, and several are known from temperate Asia.

While several species from tropical and warm temperate areas are cultivated in California and Florida, only four species are documented as being cultivated in our area. Rehder (1940, 1949) included *Diospyros armata* Hemsley, Jour. Linn. Soc. London Bot. 26: 69. 1889, and *D. sinensis* Hemsley, *Ibid.*: 71, both from China, in his *Manual and Bibliography*, but I have seen neither specimens from cultivation nor mention of their cultivation in North America; *D. armata* is, however, occasionally grown in gardens in England. Moreover, plants are grown within our region under the invalid name *D. duclouxii* Dode ex Pourtet (see under *D. lotus*).

The wood of several species of *Diospyros* is valued for lumber, and ebony, the wood of *D. ebenum* Koenig ex Retzius (see R. A. Howard & T. Norlindh, Jour. Arnold Arb. 43: 94-102. pls. 1-5. 1962), is of considerable commercial value. The edible fruits of some species are also of importance as minor orchard crops, while the green, unripe fruits of *D. kaki* var. *silvestris* are used to make a waterproofing varnish oil in China (Wilson, 1913, p. 73). Numerous species of *Diospyros* are also considered to be of value medicinally, and throughout Asia numerous medicinal uses for different parts of the plants are known (personal communication, L. M. Perry). Still other species, particularly in the American tropics, are used as fish poisons.

The sexuality of individual plants and the production of fruit by species of *Diospyros* (particularly that of *D. kaki* and *D. virginiana*) in our area are variable and merit further investigation. Many carpellate plants fail

to hold and develop fruit to maturity due to the lack of staminate plants to insure pollination. Other plants, however, produce seedless fruits without pollination as the result of parthenocarpic development. Hume (1913) observed that, in addition to variability in fruit production, most plants of *D. kaki* produce either staminate or carpellate flowers, while occasional trees produce two or three types of flowers, viz. staminate, carpellate, and perfect. Some staminate trees produce perfect flowers (occasionally resulting in the development of fruits), and some carpellate plants either sporadically or regularly produce branchlets with staminate flowers and rarely a few perfect flowers (usually in association with the staminate flowers). Due to the scarcity of perfect flowers, they are not described in the descriptions that follow.

Hybrids between *Diospyros kaki*, *D. lotus*, and *D. virginiana* are mentioned by Grubov (1967), who states that these closely related species cross readily. J. C. McDaniel (personal communication), however, has informed me that interspecific hybridization in *Diospyros* appears to be considerably more difficult than in *Magnolia* (Magnoliaceae), and Morettini (1947) reported that he could not obtain interspecific hybrids between these three species. Reciprocal crosses between *D. kaki*, $2n = 90$, and plants of the hexaploid race, $2n = 90$, of *D. virginiana* have resulted in seed production when *D. virginiana* was used as the carpellate parent. However, the plants of the resulting F_1 generation "appear to have purely maternal inheritance . . ." (McDaniel, 1973). This evidence, together with the occasional parthenocarpic development of seedless (and seeded?) fruits suggests that some apomictic mechanism(s) may be present in *Diospyros*.

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KEY TO THE SPECIES OF DIOSPYROS IN CULTIVATION

1. Plants usually trees, rarely shrubs; leaf blades membranaceous to subcoriaceous, (1.4-)4-16(-20) cm. long, distinctly petiolate; flowers appearing after the leaves; anther sacs dehiscent by long, longitudinal slits; carpellate flowers with staminodia; fruits reddish through orange to yellow or yellowish-brown, sometimes purplish, rarely black. 2.
2. Branchlets \pm slender, glabrous or with grayish pubescence; staminate flowers 6-10 mm. long at anthesis; pedicels of carpellate flowers 2-7 mm. long, the corolla 5-12 mm. long; fruits to 4 cm. in diameter (very rarely larger). 3.
3. Petioles (0.5-)1.8-3.2(-4.7) cm. long; staminate flowers 8-10 mm. long at anthesis; corolla of carpellate flowers ca. 12 mm. long, the 4 or 5 lobes 7-8 mm. long; mature berries reddish-orange to pinkish-yellow, rarely purplish or black, to 4 cm. (or rarely to 7.5 cm.) in diameter; seeds 11-17 mm. long. 1. *D. virginiana*.
3. Petioles 0.7-1.2(-2) cm. long; staminate flowers 6-7 mm. long at anthesis; corolla of carpellate flowers ca. 5 mm. long, the 4 or 5 lobes 2-3 mm. long; mature berries yellowish-brown to bluish-black, to 2 cm. in diameter; seeds 8-12 mm. long. 2. *D. lotus*.
2. Branchlets \pm stout, variously fulvous-pubescent; staminate flowers 11-14 mm. long at anthesis; pedicels of carpellate flowers 8-32 mm. long, the corolla ca. 15 mm. long; fruits to 7.5 cm. in diameter. 3. *D. kaki*.
1. Plants usually shrubs, rarely small trees; leaf blades coriaceous, (1.4-)2.4-4.8 cm. long, subsessile; flowers appearing with the expanding leaves in spring; anther sacs dehiscent by short, apical slits; carpellate flowers lacking staminodia; fruits black. 4. *D. texana*.

1. *D. virginiana* Linnaeus, Sp. Pl. 2: 1057. 1753. FIGURE 1, a-h.

Irregularly branched deciduous trees, often with \pm pendulous branches, to 10 or 15 m., rarely to 35 m., or occasionally shrubs, the plants often suckering from the roots; bark hard, brownish or blackish, irregularly and deeply fissured into small, blocklike plates; branchlets slender, greenish-to purplish-tan, lenticellate, finely to densely villous and/or glandular-pubescent, becoming glabrous in age and sometimes deciduous at 2 or 3

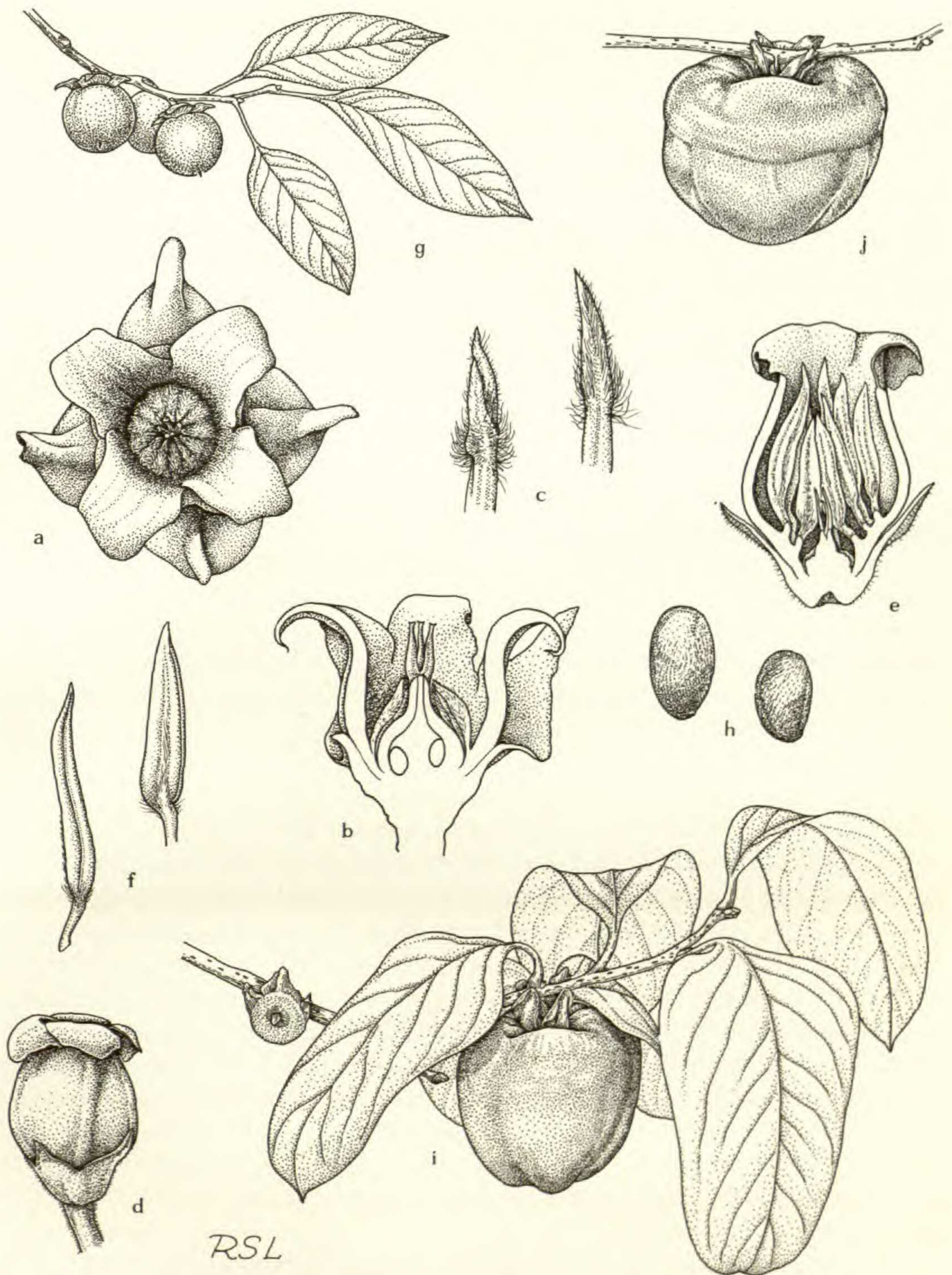


FIGURE 1. *Diospyros*. a-h, *D. virginiana*: a, carpellate flower showing foliaceous calyx lobes, recurved corolla lobes, and staminodia over the ovary, from above, $\times 3$; b, longitudinal section of carpellate flower, $\times 3$; c, two staminodia, $\times 6$; d, staminate flower, $\times 3$; e, longitudinal section of staminate flower showing epipetalous stamens and rudimentary gynoecium, $\times 4$; f, functional stamens from staminate flower, $\times 6$; g, habit of fruiting branchlet of carpellate plant, $\times \frac{3}{8}$; h, seeds, $\times 1$. i, j, *D. kaki*: i, habit of fruiting branchlet of carpellate plant, $\times \frac{3}{8}$; j, fruit of the cultivar 'Tamopan', $\times \frac{3}{8}$.

years by abscission; winter buds small, 3–4 mm. long, \pm pointed with 2 outer scales, the outermost scale overlapping the inner scale, both persistent at the base of lateral shoots. Leaves held \pm drooping; petioles (0.5–)1.8–3.2(–4.7) cm. long, finely pubescent and glandular, particularly when young; leaf blades \pm leathery, (2.9–)3.2–12(–20) cm. long, (1.4–)2–6.5(–8.4) cm. wide, elliptic to ovate or typically oblong with acute to acuminate apices, entire margins (ciliate when young, sometimes persistently), and obtuse to \pm truncate or attenuate bases; upper surfaces of the blades dull to lustrous dark green, the midveins and major lateral veins pubescent and/or glandular, otherwise glabrous; lower surfaces pale grayish-green, glabrous or with long hairs scattered over the surface, in live material the venation finely reticulate, the ultimate veinlets darker than the areolae and prominent. Flowers produced on the current year's growth, held \pm nodding beneath the leaves. Staminate flowers 8–10 mm. long at anthesis, short-pedicellate, 3 or 4 together (or fewer through abortion) in glandular-pubescent, short-pedunculate, bracteate, cymose inflorescences, the bracts caducous; calyces green, pubescent, the 4 (or 5) deltoid to linear lobes (2–)3–4 mm. long; corolla 8–10 mm. long, white, \pm urceolate and strongly 4- (or 5-)ribbed, the lobes yellowish, recurved, ca. 3 mm. long; stamens 8–16, epipetalous in 1 or 2 whorls, the largest stamens ca. 7 mm. long; gynoecia rudimentary, seemingly nectar-secreting. Carpellate flowers solitary on short, glabrous or puberulent, bracteate, persistent pedicels 4–6(–7) mm. long; calyces foliaceous, 12–14 mm. long, green, densely silvery-pubescent on the adaxial surface of the calyx tube, accrescent in fruit and sometimes persistent on the branchlets, the 4 or 5 lobes folded downward along the median line, 9–10 mm. long at anthesis; corolla white, \pm urceolate, ca. 12 mm. long, the lobes 7–8 mm. long, yellowish, recurved; staminodia 8, curved over the surface of the ovary, pubescent with long silvery hairs; ovary \pm globose, glabrous, the 4 (or 5) styles pubescent, connate basally. Berries globose, depressed-globose, oblong, or conical, to 4 cm. in diameter, often remaining on the branchlets into winter, astringent when green, becoming sweet and orangish to pinkish-yellow, often with a grayish bloom when ripe, sometimes seedless due to parthenocarpy; seeds oblong, flattened, 11–17 mm. long, the seed coats tan to reddish-brown, \pm shining. $2n = 60, 90$. — COMMON PERSIMMON, AMERICAN PERSIMMON, SIMMON, POSSUMWOOD.

Native to a wide area of the eastern United States from southern Connecticut and Long Island south to southern Florida and westward into eastern Iowa, Kansas, Oklahoma, and Texas. (See E. L. Little, Jr., *Atlas of U. S. Trees 1: map 123-E*, 1971, and H. A. Fowells, *Silvics of Forest Trees of the U. S., map*, p. 168, 1965).

Diospyros virginiana is a variable species, and several varieties and forms have been recognized. As is pointed out by Wood and Channell (1960) and reiterated by Steyermark (1963), the validity of some of these subspecific taxa, particularly var. *pubescens*, is questionable and should be considered tentative until a detailed analytic study of the variability of the

species is made. However, as Steyermark has stated (p. 1176), “. . . it would be unscientific at the present time, merely because of apparent intergradations and noncorrelations between the variations, to combine all variations into one highly variable taxon.” As a consequence, and because these variants may be encountered in cultivation, they are described below.

Plants of *Diospyros virginiana* with villous or densely tomentose branchlets and with the lower surfaces of the mature leaves obviously pubescent can be referred to var. *pubescens* Nuttall, N. Am. Sylva 2: 46. 1846 (*D. pubescens* Pursh, *D. virginiana* var. *pubescens* (Pursh) Dippel). Plants of this taxon have been recorded as occurring sporadically within the range of var. *virginiana* from Florida west to Arkansas and northward into Virginia, southern Illinois, and southern Iowa. Shrubby plants 1–4 m. high (rarely small trees) with the leaf blades smaller (3–8 cm. long, 2–4 cm. wide) than leaves of var. *pubescens* have been recognized as *D. virginiana* f. *pumila* Palmer & Steyerm., Ann. Missouri Bot. Gard. 22: 616. 1935. These plants are of local distribution in Missouri and Arkansas.

Also of localized distribution on the western edge of the species range in Missouri and Kansas southward into Arkansas and Oklahoma, plants developing depressed-globose fruits up to 7.5 cm. in diameter that ripen early in the season (July to September) and which have leaf blades broadly rounded to subcordate at base have been distinguished as *Diospyros virginiana* var. *platycarpa* Sargent, Jour. Arnold Arb. 2: 168. 1921. Other variants that correspond to var. *platycarpa* but produce dark purplish or bluish fruits have been designated as *D. virginiana* f. *atra* Sarg., *Ibid.*: 170. Finally, shrubs or small trees of peninsular Florida that produce thick-skinned fruits with plump, somewhat rugose seeds have been segregated as *D. virginiana* var. *mosieri* (Small) Sarg., *Ibid.*: 170. (*D. mosieri* Small, Jour. N. Y. Bot. Gard. 22: 33. 1921).

During the late 19th and early 20th centuries, considerable interest centered around *Diospyros virginiana* as a potential orchard crop in the United States. Several cultivars, selected primarily for fruit color, taste, size, and earliness of maturation, were selected from wild populations and named. Lists and descriptions of many of these cultivars (most probably no longer available commercially) are to be found in Bailey (1902), Fletcher (1915), Troop and Hadley (1896) and Watts (1899). Interest in and selection of *D. virginiana* cultivars has continued to the present, primarily in the Midwest. Recently described cultivars are discussed by Brooks and Olmo (1972) and in several articles by J. C. McDaniel.

2. *D. lotus* Linnaeus, Sp. Pl. 2: 1057. 1753.

Small, deciduous trees with rounded crowns, in nature to ca. 26 m. (*vide* E. H. Wilson), in cultivation usually smaller; bark smooth, grayish, in age becoming rough and deeply fissured into small blocklike plates; branchlets slender, green, becoming reddish-brown or orange-brown, eventually light grayish- or silvery-tan, finely pubescent or glabrous, the periderm finely striated, lenticellate; winter buds small, 4–6 mm. long, with 2 outer

scales, the outermost scale overlapping the inner scale, both persistent at the base of lateral shoots. Petioles 0.7–1.2(–2) cm. long, glabrous or finely pubescent, often with orange glands; leaf blades membranaceous, (4.1–) 5–15(–19) cm. long, (1.8–) 3.5–5.8(–7.5) cm. wide, narrowly lanceolate or broadly elliptic to ovate or usually oblong with short-acuminate apices, entire margins (sparsely ciliate when young), and obtuse to attenuate bases; upper surfaces of the blades glossy dark green, glabrous or with hairs scattered along the midveins, rarely with hairs over the lamina; lower surfaces pale grayish-green usually sericeous or with hairs scattered over the lamina, sometimes glabrous, in live material the venation not appearing decidedly reticulate, the ultimate veinlets not prominent. Flowers produced on the current year's growth, held \pm nodding beneath the leaves. Staminate flowers 6–7 mm. long at anthesis, short-pedicellate, 3–5 together (or fewer through abortion) in rufous-pubescent, short-pedunculate, bracteate, cymose inflorescences, the bracts caducous; calyces green, finely pubescent, the 4 (or 5) deltoid lobes 1.5–2 mm. long; corolla 4.5–6 mm. long, white, \pm campanulate and weakly 4- (or 5-)ribbed, the lobes pinkish or yellowish, recurved, ca. 2 mm. long; stamens 16, rarely fewer, epipetalous in 2 whorls, the largest stamens ca. 4 mm. long; gynoecia abortive or rudimentary. Carpellate flowers solitary on short, pubescent, bracteate pedicels 2–3 mm. long; calyces green, 7–8 mm. long, densely rufous-pubescent on the adaxial surface of the calyx tube, accrescent in fruit and sometimes persistent on the branchlets, the 4 or 5 lobes foliaceous, 6–7 mm. long at anthesis; corolla reddish-brown, broadly urceolate, ca. 5 mm. long, the lobes 2–3 mm. long, \pm recurved; staminodia 8, curved over the surface of the ovary, pubescent with long, silvery hairs; ovary \pm globose, glabrous or pubescent at apex, the 4 (or 5) styles glabrous or finely pubescent, connate basally. Berries globose to ovoid, up to 2 cm. in diameter, astringent when green, becoming yellowish-brown to bluish-black, often with a waxy bloom, and sweet when ripe; seeds oblong, flattened, 8–12 mm. long, the seed coats brown, $2n = 30$. (*D. lotus* var. *typica* Makino; including *D. japonica* Siebold & Zuccarini, *D. lotus* var. *japonica* (Sieb. & Zucc.) Franchet, *D. kaki* var. *glabra* A. DC., *D. lotus* var. *glabra* (A. DC.) Makino, *D. duclouxii* Dode ex Pourtet.) — DATE PLUM.

Cultivated since ancient times; judged to be native to a wide area from Asia Minor and the Caucasus through Afghanistan, the northwestern Himalayan region, and into China. Widely cultivated in the Mediterranean area where the plants are valued for their sweet, datelike fruits, *Diospyros lotus* has become naturalized in the Balkan Peninsula and in other areas of southern Europe; it is also cultivated throughout most of China and Japan, both for its fruits and as a rootstock onto which scions of *D. kaki* are grafted.

Makino (Tokyo Bot. Mag. 26: 396, 397. 1912) has recognized three forms of *Diospyros lotus* based on fruit shape. *Diospyros lotus* f. *GLOBOSA*, with globose fruits, is listed as the wild type, while f. *OVOIDEA*, fruits ovoid, and f. *ELLIPSOIDEA*, fruits ellipsoid, are known from cultivation. I have

not seen these variations in cultivation in our area, but it is likely that they should be treated as cultivars, much as similar variations in the fruits of *D. kaki* have been treated.

Diospyros duclouxii Dode ex Pourtet, Ann. École Nat. Eaux & For. 9: 576. 1949 (an invalid name lacking a Latin description), included here tentatively in the synonymy of *D. lotus*, was described briefly and attributed to Dode by Pourtet. Plants are grown under this name in several botanical gardens and arboreta in the United States and Europe, but based on the few specimens that I have seen, it would appear that the plants are variants of *D. lotus*. Pourtet states (translation mine), "Asia: China. This species appears quite distinct: the acuminate leaves remain pubescent on the upper surface and the young bark fissures into small, squarish platelets similar to those of *D. virginiana*." These characters, however, seem insufficient to distinguish the plants as a different taxon.

3. *D. kaki* Linnaeus f., Suppl Pl. 439. 1781.

FIGURE 1, i & j.

Moderate-sized, deciduous trees to ca. 14 m., usually with rounded crowns, or rarely large shrubs; bark pale gray, scaly, sometimes exfoliating in irregular patches, or, in grafted cultivated plants, the bark usually grayish or brownish and furrowed; branchlets \pm stout, brownish-gray or reddish- to orange-brown, variously fulvous-pubescent, eventually glabrous and lenticellate; winter buds small, 4–5 mm. long, ovoid to subglobose, usually pubescent, with 2 outer scales, the outermost scale overlapping the inner one, both persistent at the base of lateral shoots. Leaves held \pm drooping, becoming reddish-orange in fall; petioles (0.5–)1–2.2(–3) cm. long, sparingly to densely pubescent; leaf blades variable in size and shape, \pm subcoriaceous, (5–)6.5–16(–20) cm. long, 3–8.8(–11) cm. wide, ovate to oblong-ovate, broadly elliptic, obovate, or sometimes suborbicular, with truncate or rounded to cuneate bases, entire margins, and obtuse, acute, or (usually) acuminate apices; upper surfaces of the blades dark, glossy green, glabrous or with hairs along the veins and sometimes scattered over the surface; lower surfaces paler green, variable in indumentum, usually fulvous-villous along the veins and often sparingly pubescent over the surface, the midveins and 5 or 6 pairs of lateral veins prominent, elevated, the lower lateral veins ending high on the blade. Flowers produced on the current year's growth, held \pm nodding beneath the leaves. Staminate flowers 11–14 mm. long at anthesis, short-pedicellate, 3–5 together (or fewer through abortion) in fulvous-pubescent, short-pedunculate, bracteate cymose inflorescences, the bracts caducous; calyces green, glabrous or sparingly pubescent, the 4 ovate to deltoid lobes 3–7 mm. long; corolla 10–13 mm. long, light yellow, \pm campanulate to \pm urceolate, the 4 lobes recurved, ca. 5 mm. long; stamens 16–24, epipetalous in 2 or 3 whorls, the largest stamens ca. 8 mm. long; gynoecia abortive or rudimentary. Carpellate flowers solitary on pubescent, bracteate pedicels (8–)14–20(–32) mm. long in the axils of leaves; calyces green, densely rufous- or fulvous-pubescent on the adaxial and abaxial sur-

faces of the calyx tube, 15–22 mm. long, accrescent in fruit and sometimes persistent on the branchlets, the 4 lobes foliaceous, 15–17 mm. long at anthesis; corolla yellowish, broadly urceolate, ca. 15 mm. long, the 4 lobes 6–8 mm. long at anthesis with ciliate margins, \pm recurved; staminodia 8, curved over the surface of the ovary, pubescent with long, silvery hairs; ovary depressed-globose, globose, or conical, glabrous, the 4 styles pubescent, connate basally. Berries to 7.5 cm. in diameter, variable in shape, globose or depressed-globose to oblong or conical, sometimes with longitudinal furrows and occasionally with a \pm hemispherical or basal constriction, astringent when green (or some cultivars sweet when hard and green), becoming sweet, and yellow through orange to reddish when ripe, sometimes seedless due to parthenocarpy; seeds variable in size and shape, broadly to narrowly oblong, flattened, 1–3 cm. long, the seed coats dark brown. $2n = 90$. (*D. chinensis* Blume, *D. kaki* var. *domestica* Makino; including *D. roxburghii* Carrière, *D. lycopersicon* Carrière.) — KAKI, JAPANESE PERSIMMON, CHINESE PERSIMMON, ORIENTAL PERSIMMON, PERSIMMON.

An exceedingly variable species (sometimes divided into several species) widely cultivated throughout China and Japan where a myriad of cultivars has been developed, selected, and grown since remote antiquity; also grown in regions of temperate and warm temperate climates throughout the world. In our area *Diospyros kaki* is known to be hardy as far north as the Philadelphia region, and it is also grown successfully in Massachusetts on Martha's Vineyard.

Diospyros kaki var. *silvestris* Makino, Tokyo Bot. Mag. 22: 159. 1908, oil-persimmon, is the reputed wild plant from which the kakis in cultivation have been derived, but it should be noted that Hume (1914) has suggested that the cultivated kakis are of hybrid origin and have two or more species in their genetic background. According to Rehder and Wilson (1916, p. 590), plants of var. *silvestris* occur as escapes from cultivation in Japan and China, and Wilson (1913, p. 73) reports that it is "abundant in the mountains of central and western China up to 4000 feet altitude, where it forms a large tree 50 or 60 feet tall." Grubov (1967), however, has suggested that the wild progenitor of the cultivated forms was originally native to northern China where it was an element of the deciduous forest vegetation.

Specimens of *Diospyros kaki* var. *silvestris* that I have seen are extremely variable, and some are difficult if not impossible to distinguish from specimens of var. *kaki*, to which the above description applies. The majority of specimens of var. *silvestris* have smaller leaf blades (generally about 10.5 cm. long and 4.5 cm. wide), densely fulvous-pubescent branchlets and petioles, and smaller flowers, the carpellate ones often with pubescent ovaries. The fruits generally contain seeds, are golden yellow at maturity, and are mostly smaller (1.5–5 cm. in diameter) than those of var. *kaki*. While I have not seen specimens documenting its occurrence as a cultivated plant in this country, it might be expected in some arboretum collections.

Moreover, plants grown from seed of var. *kaki* might be expected to represent reversions to this wild type.

Among the possibly more than 1000 horticultural forms of *Diospyros kaki* var. *kaki*, Rehder (1940, 1949) accounted for 'Costata' (= *D. kaki* var. *costata* (Carrière) André, *D. costata* Carrière), a cultivar that produces large, orange-red, depressed-globose fruits with four longitudinal furrows, and 'Mazeli' (= *D. kaki* var. *mazeli* (Carrière) Mouillefert, *D. mazeli* Carrière), a variant producing large orange-yellow fruits with eight longitudinal furrows. Other notable cultivars include 'Tamopan' (see F. N. Meyer, 1911), which produces large, seedless, \pm depressed-globose, \pm four-sided reddish-orange fruits with an equatorial or \pm basal constriction (FIGURE 1, j); and 'Hachiya', the cultivar probably most commonly seen in produce markets. The fruits of 'Hachiya' are oblong-conical, with glossy deep orange-red skin, and deep yellow flesh which remains astringent until soft. 'Gailey' is another important cultivar inasmuch as it is planted for its dependable production of some staminate flowers on otherwise carpellate individuals. These staminate flowers provide a source of pollen for pollination of other cultivars. For information and descriptions of many other cultivars of *D. kaki*, reference should be made to Gould (1940), Condit (1919), Ryerson and Hodgson (1933), Brooks and Olmo (1972), and Bailey (1902).

Apparently, most of the cultivars of the kaki produce fruit through parthenocarpic development, but the production of fruit is often erratic when pollination and fertilization are not insured. Hume (1913, 1914) found that fruit production was assured on a regular basis if carpellate trees that regularly produce some branchlets with staminate flowers are included in orchard plantings. He classed the cultivar 'Gailey' as a "staminate constant" due to its regular abundant production of staminate flowers, while 'Hachiya' and 'Tamopan', among others, were termed "pistillate constants," since they have never been observed to produce staminate flowers.

Hume also noted that in some clones the color of the flesh of the mature fruits is the same regardless of parthenocarpic development or development following pollination and fertilization. In other clones the flesh color of fruits developing after pollination and fertilization is darker than the flesh of parthenocarpic fruits of the same clone. On the basis of this reaction (or non-reaction), Hume placed several cultivars into two groups, viz. pollination constants, clones which undergo no color changes as a result of pollination, and pollination variants, clones in which flesh color of mature fruits is darker if developed from pollinated and fertilized flowers. This informal classification is mentioned here since some nurseries and commercial growers employ it when selling and discussing named cultivars.

4. *D. texana* Scheele, *Linnaea* 22: 145. 1849.

Twiggy, deciduous shrubs or small trees, rarely to 16 m.; bark of older limbs smooth, light reddish-gray or reddish-brown, the outer layers exfo-

liating in irregular sheets, exposing the smooth, gray, inner bark; branchlets slender, silvery-gray, at first densely hirsute, eventually glabrous; winter buds very small, densely pubescent. Leaves sometimes persistent into winter, subsessile, the petioles 0.5–3 mm. long; leaf blades coriaceous, (1.4–)2.4–4.8 cm. long, (0.6–)1.3–2.2 cm. wide, obovate to oblong-obovate, with rounded, \pm truncate, or sometimes shallowly emarginate apices, entire revolute margins, and cuneate bases; upper surfaces of the blades dark lustrous green, usually finely hirtellous; lower surfaces paler green, reticulate, hirsute. Flowers appearing in spring with the expanding leaves, produced on the current year's growth. Staminate flowers 7–8 mm. long at anthesis, borne on slender, hirtellous, bracteate pedicels, solitary or usually 2 or 3 together in short-pedunculate, cymose inflorescences; calyx green, divided almost to the base into 5 (or 6) pubescent, oblong to ovate lobes, the lobes ca. 3 mm. long; corolla 7–8 mm. long, creamy white, \pm campanulate with 4 or 5 short, spreading to recurved lobes, the lobes sericeous on the abaxial surfaces; stamens usually 16, rarely fewer, epipetalous in 1 or 2 whorls, glabrous, the linear-lanceolate anther sacs apically dehiscent by short slits; gynoecia abortive or vestigial. Carpellate flowers solitary (rarely 2 together) on stout, bracteate, hispid pedicels ca. 4 mm. long; calyces 6–7 mm. long, divided almost to the base into 5 oblong, pubescent lobes, the lobes ca. 6 mm. long; corolla creamy white or greenish, broadly urceolate to \pm campanulate, ca. 8 mm. long, the 5 lobes ca. 4 mm. long, spreading to recurved, rounded; stamens and/or staminodia lacking; ovary globose to ovoid, densely pubescent, the 4 glabrous styles connate at base and coherent for most of their length. Berries shining black and sweet at maturity, subglobose or depressed-globose, finely pubescent, 1.2–2.5 cm. in diameter, subtended by the accrescent calyx; seeds \pm oblong, ca. 11 mm. long, the seed coats grayish-black with a \pm metallic luster. $2n = 30$. (*Brayodendron texanum* (Scheele) Small.) — BLACK PERSIMMON, MEXICAN PERSIMMON, CHAPOTE.

Endemic to central and western Texas and northern Mexico in the states of Coahuila, Nuevo Leon, and Tamaulipas. Although it is rarely cultivated, we have evidence that *Diospyros texana* is included in the collections at Longwood Gardens and at Colonial Williamsburg, Virginia.

As pointed out by Sargent (1894), this species should prove valuable in cultivation for its attractive, lustrous foliage, the interesting black fruits of carpellate plants, and its mottled bark resembling that of the crape-myrtle (*Lagerstroemia indica* L., Lythraceae). Standley (1924, p. 1127) notes, however, that the fruits of *Diospyros texana* leave "an indelible black stain upon everything with which [they] come in contact . . ."

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